Plant Document Analysis

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End of Engineering Analysis Report

ENGINEERING SPECIFICATION ANALYSIS

Focus Area: Nozzle load analysis

Generated on December 03, 2025

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Section 1: Accepted Specifications for Evaluation of Nozzle Load Analysis

• Applicable codes / analysis standards called out:

• Piping design: ANSI B31.3 (document: "All process piping shall be as per ANSI B31.3").

• Seismic design: IS 1893 (document: "All seismic design shall fully comply with the IS 1893 code").

• Pressure vessel design: ASME Section VIII Div.1 or Div.2 for vessels/columns (mechanical design section).

• Heat exchangers / nozzles: TEMA and ASME Section VIII Div.1 called for shell & tube exchangers.

• Piping stress analysis software recommended: Caesar, NOZZLEPRO, CAEPIPE (listed under Software to be used).

• Design pressure / margin rules relevant to nozzle mechanical loads (explicit table):

• For Max Operating Pressure ≤ 1.8 kg/cm2g → typical Design Pressure 3.5 kg/cm2g.

• to 17.6 kg/cm2g → Design Pressure = Max Operating Pressure + 1.8 kg/cm2g.

• to 35.2 kg/cm2g → Design Pressure = Max Operating Pressure × 1.1.

• to 70.3 kg/cm2g → Design Pressure = Max Operating Pressure + 3.5 kg/cm2g.

• Over 70.3 kg/cm2g → Design Pressure = Max Operating Pressure × 1.05.

• Note: maximum static head can be additive to margins; margins intended to account for typical PSV blowdown/simmer.

• Nozzle and vessel connection rules relevant to load assessment:

• "Connections on pressure vessels shall be flanged, unless welded construction is preferred for reasons of safety."

• "Separate 2" nozzle shall be provided as steam-out or utility connections."

• Minimum nozzle size on pressure vessels (spheres & bullets section): "On pressure vessels, minimum nozzle size shall be 1 ½"."

• Heat exchanger nozzle provisions:

• Vent/drain (on either side): 1½" nozzle with blind flange if not vented/drained from process nozzle.

• Drain valve of adequate size (3" minimum) with spectacle blind to be provided on cooling water supply line downstream of isolation valve for back-flushing.

• Multi-purpose connections (50 NB) to be provided on all process nozzles of heat exchangers.

• All heat exchangers to have ¾" utility connection on inlet/outlet nozzles for hydrotest.

• Thermowells at inlet/outlet on both shell & tube side (cooling water only on outlet).

• Materials / corrosion allowance that affect nozzle thickness/allowable stresses:

• Corrosion allowances (static equipment): Carbon steel / low alloy up to 2¼% Cr → 3 mm; low alloy >2¼% Cr to 9% Cr → 1.5 mm.

• Cladding/overlay: minimum 2 mm cladding; cladding thickness considered as CA with minimum 3 mm.

• For storage tanks: shell/bottom CA = 1.5 mm; roof = 1.0 mm.

• Piping / system design bases affecting nozzle loads:

• Use of ANSI B31.3; hydraulics and pressure drop per piping DBD.

• Control valve manifold, block/bypass valve arrangements (affects local piping loads and flange/nozzle loads).

• Piping sizing guidelines: utilities headers sized with 10%/20% margins (affects pressures and consequent nozzle loads).

• Wind & environmental loads (relevant for attached piping/nozzle loads on equipment elevated or exposed):

• Onshore 3 s gust: 50 m/s at 10 m elevation (50-year return).

• Offshore operational: 15 m/s (5-year); extreme survival 33 m/s (500-year).

• Selections of analysis tools:

• Piping stress / nozzle load analysis tools called out: Caesar, NOZZLEPRO, CAEPIPE (document explicitly lists these).

• Piping / nozzle design interfaces:

• Piping and vessel/nozzle isolation requirements (spectacle blinds, spades, double block where applicable) are specified and may influence piping topology and loads at nozzle.

Section 2: Measurements Provided in Document

(The following are explicit numerical values in the submitted document relevant to nozzle load analysis — pressures, temperatures, wind, and minimum nozzle sizes / nozzle-related dimensions)

- Wind / environmental:
- Onshore 3-second gust wind speed: 50 m/s (measured at 10 m elevation; 50-year return).
- Offshore operational mean hourly wind speed: 15 m/s (10 m elev; 5-year).
- Offshore extreme survival mean hourly wind speed: 33 m/s (10 m elev; 500-year).
- Wind speed for flare heat radiation: 11.5 m/s.
- Temperatures (site / design):
- Maximum recorded DBT: 48 °C.
- Minimum recorded DBT: 3 °C.
- Design Temperature (DBT) for Air Coolers: 41 °C.
- Electrical design temperature outdoors: 43 °C; indoors equipment 40 °C.
- Design Surface Temperature (surfaces exposed to solar): 65 °C.
- Winterizing Temperature: 10 °C.
- Low Ambient Design Temperature: 7.5 °C.
- Nozzle sizes / openings (explicit):
- Minimum nozzle size on pressure vessels (spheres & bullets): 1½" NB.
- Vessels: vent nozzle sizes:
- Vent up to 6 m3 → 1½"
- Vent above 6 m3 → 2"
- Drain up to 6 m3 → 1½"
- Drain 6.1–15 m3 → 2"
- Drain above 15 m3 → 3"
- Vessel manway sizes:
- Vessel dia 900–1500 mm → 20" NB manhole
- Vessel dia >1500 mm → 24" NB manhole
- Minimum manhole ID = 20"

• Heat exchanger nozzle notes:

• Multipurpose connection: 50 NB on all process nozzles.

• Vent/drain nozzle: 1½" with blind flange (if required).

• Drain valve min 3" plus spectacle blind on cooling water supply downstream.

• ¾" utility connection on inlet/outlet nozzles for hydrotest.

• Preferred tube lengths and tube OD/minimums (tube specs included; relevant to exchanger nozzle stiffness).

• Battery-limit / utility pressures and temperatures (explicit values useful for nozzle boundary conditions):

• Raw water to cooling tower: Normal 4 kg/cm2g; Design 7 kg/cm2g; Design temp 65 °C (supply listed as ambient/65°C design).

• Demineralized water: Normal 7 kg/cm2g; Design 10 kg/cm2g; Design temp 65 °C.

• Potable water: Normal @ source 3.8 kg/cm2g; process battery limit 3.5 kg/cm2g; user 3 kg/cm2g; Design 7 kg/cm2g; user normal temp 35 °C; max 43 °C; design 65 °C.

• Cooling water (DTA/SEZ typical): supply pressure at source 5.1 kg/cm2g; supply temp 32 °C; return pressure at unit battery limit 2.8 kg/cm2g; return temp 45 °C.

• Fuel gas: normal 3.9 kg/cm2g; min 3.2; max 4.6; design 6.5 kg/cm2g; normal temp 38 °C; max listed 94 °C; design 120 °C.

• Boiler Feed Water (HHP/HP/MP/LP) — normal and design pressures listed:

• HHP BFW normal 127.7 kg/cm2g; design 163.2 kg/cm2g.

• HP BFW normal 59.2 kg/cm2g; design 78 kg/cm2g.

• MP BFW normal 23.9 kg/cm2g; design 33.8 kg/cm2g.

• LP BFW normal 10.9 kg/cm2g; design 17.6 kg/cm2g.

• Steam battery limits (pressures in kg/cm2g and temperatures in °C):

• HHP Steam: Min 101; Normal 106; Max 109; Design 117 kg/cm2g; temperatures Min 490; Normal 510; Max 515; Design 540 °C.

• HP Steam: Min 40.1; Normal 42.2; Max 43.2; Design 47.6 kg/cm2g; temps Min 381; Normal 383; Max 399; Design 426 °C.

• MP Steam: Min 15; Normal 16; Max 17.2; Design 21.1 kg/cm2g; temps Min 201; Normal 232; Max 260; Design 288 °C.

• LP Steam: Min 3.5; Normal 4.1; Max 4.6; Design 8.1 kg/cm2g; temps Min 147; Normal 158; Max 232; Design 260 °C.

• Condensate battery limits (pressures and saturation temperatures at grade):

• HP condensate normal 42.2 kg/cm2g (temps ~254 °C).

• MP condensate normal 16 kg/cm2g (~203 °C).

• LP condensate normal 4.1 kg/cm2g (temperatures given as saturation; see note).

• Plant / instrument / breathing air battery limits:

• Plant Air normal 7.7 kg/cm2g; design 10 kg/cm2g; temp normal 40 °C.

• Instrument Air normal 7 kg/cm2g; design 10 kg/cm2g.

• Breathing air normal 9.1 kg/cm2g; design 10 kg/cm2g.

• Nitrogen battery limit pressures:

• High Pressure Nitrogen normal 13.7 kg/cm2g; design 15.4 kg/cm2g.

• Low Pressure Nitrogen normal 7 kg/cm2g; design 10.5 kg/cm2g.

• Other nozzle-relevant construction/analysis notes:

• Piping impulse lines to be insulated/traced where required (affects thermal loading and rigidity).

• Hydrocarbon lines run above ground; firewater and cooling water >24" OD above ground in OSBL (affects routing and loads).

• Prohibited pipe sizes: 1¼", 2½", 3½", 5", 9" (affects available nozzle connection sizes and piping branching).

• Piping stress analysis software explicitly prescribed (see Section 5.2).

Section 3: Inputs and Additional Requirements from Client (as stated or called out in the document)

• Provided inputs in the document (explicitly stated and relevant to nozzle load analysis):

• Codes to use: ANSI B31.3, ASME Section VIII (Div I/II), IS 1893 for seismic.

• Recommended stress-analysis software: Caesar, NOZZLEPRO, CAEPIPE.

• Wind design values and return periods (see Section 2 above).

• Steam/utility battery-limit pressures and temperatures (see Section 2 above) to be used as boundary conditions.

• Vessel/nozzle minimum sizes and heat exchanger nozzle provisions (see Section 2 above).

• Design pressure margin rules (table for adding margins to operating pressures).

• Requirements that Licensor/DEC/OSBL designer must "ensure" battery-limit parameters and populate missing numbers as design progresses.

• Explicitly called-out items in the document that are required but not provided (i.e., missing inputs needed to perform a complete nozzle load analysis — these are identified in the document as items to be defined or left to OSBL / DEC / vendor):

• No explicit nozzle loads (forces and moments) are provided in the document.

• No nozzle coordinates / nozzle orientations / exact attachment locations on vessels/ exchangers (document requires OSBL/DEC to populate where not provided).

• No piping geometry, span lengths, weight data, thermal growth data, or anchor/restraint details for specific nozzle attachments.

• No detailed seismic response spectra or response coefficients — only the requirement to follow IS 1893 is stated.

• No explicit allowable nozzle load values or vendor-provided allowable loads (document references standards but gives no allowable nozzle load tables).

• No flange rating / connecting piping class schedules are given per nozzle; only general piping pressure classes and battery-limit pressures are listed.

• No dynamic/transient design load cases (e.g., waterhammer or compressor trip forces) are specified for nozzle loads.

• Several utility battery-limit values are marked "To be confirmed" or "will be firmed up as design progresses" — these need finalization before boundary conditions can be set.

• For heat exchangers, some tube/ nozzle dimensions and flange details are specified generally (e.g., 50 NB multipurpose), but detailed nozzle reinforcement, neck length, welding details and nozzle neck thicknesses are not provided.

• Document directions that affect the nozzle-load analysis workflow (i.e., actions the client expects):

• OSBL designer / DEC / Licensor to populate missing battery limit conditions, process data and nozzle interface data as the design evolves.

• Where conflict exists between this document and process-specific licensor data, licensor data and PMT/OWNER decisions prevail — nozzle loads must use final licensor data.

• Piping stress analysis must be performed with approved software (Caesar/NOZZLEPRO/CAEPIPE) and follow piping and vessel codes referenced.

• The document instructs that mechanical design will follow ASME Section VIII Div.1 or Div.2 — nozzle reinforcement / allowable stresses must comply accordingly.

• Use ANSI B31.3 piping code for process piping design and follow ASME VIII for vessel mechanical design.

• Use recommended piping/nozzle analysis software (Caesar, NOZZLEPRO) for stress and nozzle load evaluation.

• Use battery-limit pressures/temperatures listed in Attachment 3 as boundary conditions unless superseded by licensor/DEC data.

• Apply the design pressure margins table when determining mechanical design pressures (affects pressure-induced radial loads on nozzles).

• Adopt site wind and seismic criteria per document for environmental load cases.

End — extracted only items explicitly stated in the submitted document that are relevant to performing nozzle load analysis.

End of Engineering Analysis Report